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PACKAGING PERFORMANCE TESTING
OF A
CORRUGATED FIBERBOARD BOX (16 IN. BY 16 IN. BY 16 IN.), CONTAINING FOUR
1-GALLON PAINT CANS WITH BAILS AND LOCKING RINGS – PACKING GROUP I

ALL TRANSPORTATION MODES

Date: 17 May 2004

AFPTEF PROJECT NUMBER: 04-P-101
POP TEST ID NUMBER: DODPOPHM/USA/DOD/AF69/DLA-F058

Part 1.

A. Title: PACKAGING PERFORMANCE TESTING OF A CORRUGATED FIBERBOARD BOX (16 IN. BY 16 IN. BY 16 IN.), CONTAINING FOUR 1-GALLON PAINT CANS WITH BAILS AND LOCKING RINGS – PACKING GROUP I

Report Number: DLA-F058

AFPTEF Project Number: 04-P-101

Manhours: 40

Report Type: FINAL

B.

TEST REPORT APPLICABILITY STATEMENTS see section 2E.

Report Prepared by:

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Testing Completion Date: 11 May 04

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Responsible Individual: Robbin L. Miller

Performing Activity: AF Packaging Technology and Engineering Facility
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Specific Authority: Distribution Statement F. Further dissemination only as directed by AFMC LSO/LOP or higher DoD authority.

Requesting Organization: Defense Distribution Center
DDC-J-3/J-4-0
ATTN: POP Team
2001 Mission Drive
New Cumberland PA 17070

Part 2. Data Sheet**A. Exterior Shipping Container****UN Type:** Fiberboard box**UN Code:** 4G**NSN:** 8115-00-190-5002**Specification Number(s):** ASTM D5118, Style RSC, ASTM D4727, Type CF, Class WR, Var SW, Gr 400, V3c**Container Manufacturer:** Lynchburg Sheltered Industries, Lynchburg, VA 24501**Date of Manufacture:** October 2003 (GSA advice code "2G" – newest stock)**Material:** Corrugated Fiberboard**Container Dimensions:** 16 in. x 16 in. x 16 in. ID**Closure (Type/Method):** ASTM D1974, Sealing Method 2B (7-Strip Method).**Closure Specification Number(s):** A-A-1830 clear tape, 2-inch, NSN 7510-00-266-6715.**Reinforcement (Type/Method):** ASTM D1974, Reinforcement Method 2B, using 1-inch wide filament reinforced tape. Two horizontal girthwise band, each approximately 4 inches from the top and bottom, and two vertical girthwise bands crossing the closure line of the box flaps at right angles, each approximately 4 inches from the side, were used after filling the box, but before sealing the box.**Reinforcement Specification Number(s):** A-A-1687 Fiber Reinforced Tape, 1-inch; NSN 7510-00-582-4772.**Absorbent Material Description:** Vermiculite, Fine Grain, Palmetto Vermiculite Company, Incorporated, Grade C-3; Hazmatpac A-900, HAZMATPAC Inc.; Absorbent GP, Absorption Corporation.**Additional Description:** N/R**B. Intermediate Package of Combination Packaging****Type:** Round Metal Can, Paint with Bail**NSN:** N/A**Manufacturer/Distributor:** Freund Container, Inc.**Date of Manufacture:** N/R**Manufacturer's Number:** 1837 **(NOTE: Not recommended for solvents or any thin product.)****Capacity:** 1 gallon (3.79 liter)**Dimensions:** 7.5 in. x 6.5 in.; opening I.D. 5.5 in. (19.1 cm x 16.5 cm; opening I.D. 14 cm)**Closure (Method/Type):** Friction Plug Lid (metal), 5-7/8 in. I.D. (14.9 cm); comes with can.**Secondary Closure (Method/Type):** Hazmatpac Ring Lock, manufacturer part number C-700 (or C-GSA-700). Air Eligibility certified by manufacturer to 95 kPa.**Additional Description:** Inner packaging of tested item (see photos, Figures 1 – 4, and drawing).**1.** Apply horizontal girthwise bands of reinforced tape to box before filling to prevent compression of absorbent from deforming box sides.**2.** Close cans using a mechanical Paint Can Closer and Overseal Applicator (Hazmatpac PN W-535; Freund PN 7855). Place Ring Lock on top of can and apply using the same tool. See Figure 1.**3.** Line the box with a 4-mil gusseted polyethylene bag, size 22 in. x 22 in. x 47 in., minimum dimensions. Place approximately 2 inches of tightly compressed absorbent in bottom of box. Place 4 cans on the absorbent layer, approximately 1.25 inches from the box sides and 0.5 inches from each other (Figure 2). Fill all open space with tightly packed absorbent until can top is reached, avoiding putting pressure on the can sides. Fill around and over the can with tightly packed absorbent to the top of the box sides to make a tight pack.**4.** Twist bag and tape closed with fiber reinforced tape (Figure 3).**5.** Closure IAW 2A (Figure 4).**C. Actual Product: Not Used****NSN:** NA**Specification:** Unknown**UN/DOT/IMO/IATA Proper Shipping Name:** Unknown**United Nations Code Number:** Unknown**United Nations Packing Group:** I**UN Hazard Class:** Unknown **DOT Hazard Class:** Unknown

IMO Hazard Class: Unknown **IATA Hazard Class:** Unknown

Physical State: LIQUID

Amount per outer container: Four 1-gallon cans (3.79 liter) [7.1 kg (15.75 lb) each, calculated from specific gravity]

Density/Specific Gravity: 1.8

Drop Height: 1.8 meters (71 in.)

Minimum Stacking Weight/Force Required: 260.4 kg (574 lb), based on vermiculite sample

Additional Description: N/A

Vapor Pressure (liquids only) at 50°C: Unknown

D. Test Product: Used

Name: Water and sand mixture

Physical State: LIQUID

Amount per outer container: Four 1-gallon cans (3.79 liter) [7.1 kg (15.75 lb)]

Gross Weight (packaged with vermiculite): 40.8 kg (90 lb)

Gross Weight (packaged with Hazmatpac A900 – for information only): 51.7 kg (114 lb)

Gross Weight (packaged with Absorbent GP – for information only): 38.1 kg (84 lb)

Density/Specific Gravity: 1.8

Drop Height: 1.8 meters (71 in.)

Minimum Stacking Weight/Force Required: 260.4 kg (574 lb), based on vermiculite sample

Additional Description: N/A

E. Test Applicability- See test results in Part 6.

(1) Tests documented herein are design qualification. It is the responsibility of the government shipper/certifier to fully verify design compliance and packaging material quality.

(2) Drop testing performed herein was tested in accordance with DLAD 4145.41, AR 700-143, AFJI 24-210, NAVSUPINST 4030.55A, and MCO 4030.40A. This joint DoD policy document allows packaging to be drop tested more than once provided the packaging continues to pass the 49CFR 178.603 requirements. Questions about or clarification of this policy can be sought from the respective preparing activities of the regulation.

(3) DoD contractor use of this test report or its resultant certifying mark only with the permission of the testing activity AND as specified in DLAD 4145.41, AR 700-143, AFJI 24-210, NAVSUPINST 4030.55A, and MCO 4030.40A.

(4) Pass/fail conclusions were based on the particular specimens, both inner and outer containers, and quantities of each submitted for test. Extrapolation to other manufacturers, applications, commodities, inner containers, container sizes, or lesser internal quantities is the responsibility of the packaging design agency or applicable higher headquarters and the limitations documented in 49CFR. Extrapolation of test results based on lesser than minimum UN/DOT required test specimens is also the responsibility of the packaging design agency or applicable higher headquarters.

(5) Reference to specification materials has been made based on one of the following methods: supplied by AFPTEF, provided by the requester, markings printed on, attached to or embossed on the packaging.

(6) Testing performed in accordance with 49CFR 170-180, except as documented in this report.

(7) Performance testing was undertaken and completed at the request of an agency responsible for management of the dangerous good(s). The completion of successful UN/DOT testing does not, by itself, authorize the marking and transportation of the dangerous good(s). Applicable modal regulations should be consulted concerning the relationship of performance testing completed and the dangerous good(s).

(8) The DOT performance tests are intended to evaluate the performance of the entire packaging configuration's ability to prevent the release of contents during conditions normally incident to transportation. The criteria used to evaluate container system performance is whether the contents of the packaging are retained intact. The successful completion of the recommended tests does not ensure undamaged delivery.

(9) Tests performed and documented, herein, in no way verify Government supplier's operations (included but not limited to: internal procedures, suppliers, or manufacturing processes) comply with the DOT's or international's regulations. The testing

facility has no knowledge and assumes no knowledge, that specific material testing requirements (i.e. plastics - only allowed to use regrind from the same operation; specific vendor plastic formulations including quantity of carbon black, ultra-violet inhibitors or pigments, or production run's individual leakproofness tests) are or were performed by the manufacturer(s) listed herein, unless otherwise noted in the report.

Part 3. Introduction.

Brief description of why specific tests were performed and rationale for the test product selected (if applicable).

Packing Group I testing, for 1.8 specific gravity liquids, was requested on the above stated configuration. For lesser volumes, variations to testing requirements can be found in 49 CFR, part 178.601(g). The total quantity of absorbent used in this packaging does meet the requirements of AFMAN 24-204(I), Atch 20, and the tested configuration is intended for all transportation modes.

Four 1-gallon round metal paint cans, each with a friction plug lid secured by a locking ring, and a bail, were used in the outer container as requested. **NOTE: Per Freund Container, these paint cans are not recommended for solvents or any thin product.**

Each packaging was subjected to appropriate drop and vibration testing as prescribed by ASTM D4919 and 49 CFR 600 - 608. These tests are designed to simulate the shock and vibration a package configuration may encounter during conditions normally incident to transportation. The order of testing was drop test followed by the vibration test; the stacking test was performed on an empty outer container. The Cobb test was performed on samples taken from boxes not otherwise used in testing.

Although this configuration was tested using vermiculite, Absorbent GP and Hazmatpac A900, test requirements were met ONLY WHEN USING VERMICULITE, therefore only vermiculite may be used provided the maximum gross weight (above) is not exceeded, and it is not incompatible with the substance(s) in the inner packagings.

The use of one sample packaging configuration for multiple tests and drops is DoD policy as stated in DLAD 4145.41, AR 700-143, AFJI 24-210, NAVSUPINST 4030.55A, and MCO 4030.40A. This option was exercised in this test as noted in Part 6.

Part 4. Tests Required/Performed (as applicable).

NOTE: Packagings fabricated from fiberboard, paperboard, or paper, including composite containers with outer fiberboard containers, should be conditioned for a minimum 24 hours prior to any testing. Standard conditions $23 \pm 3^{\circ}\text{C}$ ($73 \pm 4^{\circ}\text{F}$) and $50 \pm 2\%$ relative humidity apply.

A. Leakproofness test. 3 outer containers each individually tested for 5 minutes (30 minutes for plastic containers). **Not applicable.**

B. Hydrostatic Pressure Test. 3 outer containers each individually tested for 5 minutes at 15 psig. Manufacturer test results for Hazmatpac Locking Rings accepted.

C. Stacking Test. One test per outer container, 3 containers required. Compression by a top load is calculated to simulate a stack height of 3 meters, maintained for 24 hours. **NOTE:** If only one configuration sample is tested, test duration shall be 72 hours.

Static weight. Apply the calculated weights using a constant load evenly over the entire container.

$$M = \frac{m(3000-h)}{h}$$

where: m = container's gross mass (as shipped) in kilograms = outer container + absorbent fill + [number of inner containers * specific gravity of lading * volume of inner container * 35.8(mass of water in g) * 0.98(min. filling of inner container)] = **40.8 kg**

h = container's height in millimeters = **406.4 mm** (effective height for container in stack)

M = constant minimum load mass in kilograms = **260.4 kg**

or:
$$W = \frac{w(118-h)}{h}$$

where: w = container's gross mass (as shipped) in pounds = outer container + absorbent fill + [number of inner containers * specific gravity of lading * volume of inner container * 8.3(mass of water in lb) * 0.98(min. filling of inner container)] = **90 lb** (highest sample weight)

h = container's height in inches = **16 in.** (effective height for container in stack)

W = constant minimum load weight in pounds = **574 lb**

NOTE: Where the contents of the test sample are non-dangerous liquids with relative density different from that of the liquid to be transported, the force shall be calculated in relation to the latter.

Information - This test assumes similar weight containers stacked on top of the test sample. This may or may not be a valid assumption. This calculation also only provides a minimum weight. Consideration should be given to what will actually be experienced in the transportation cycle.

D. Drop Test. 5 drops in order: flat on the top, bottom, long side, short side and top corner. The drop height shall be appropriate for the packaging group of the commodity. The container shall strike a target which shall be a rigid, non-resilient, flat, and horizontal surface. For other than flat drops, the center of gravity shall be vertically over the point of impact. **NOTE:** All drops may be made on only one sample. If the sample fails after drops 2 through 5, it may be replaced by another sample identically loaded.

1. Solids and liquids, if the test is performed with the actual contents to be carried, or with another substance having essentially the same characteristics, or for liquids if the test is performed with water and the intended contents has density less than 1.2 g/cm³ (specific gravity less than 1.2) the drop height shall be:

<u>Packing Group</u>	<u>Drop Height</u>
I	1.8m (70.9 in.)
II	1.2m (47.2 in.)
III	0.8m (31.5 in.)

2. Where the test sample doesn't contain the intended contents and its specific gravity is greater than 1.2, then obtain the required drop height in meters by calculating the following with product density (d):

<u>Packing Group</u>	<u>Drop Height</u>
I	(d) x 1.5m ((d) x 59.1 in.)
II	(d) x 1.0m ((d) x 39.4 in.)
III	(d) x 0.67m ((d) x 26.4 in.)

Round the drop height up to the first decimal.

E. Vibration Test (domestic requirement). One test per container, total of three test specimens.

The test shall be performed for 1 hour at a frequency that causes the package to be raised from the vibrating platform to such a degree that a piece of material approximately **0.2 cm** (1/16 in.) thickness can be passed between the bottom of the package and the platform. The vibrating platform shall have a vertical double-amplitude (peak-to-

peak) displacement of **2.54 cm** (1 in.). Perform tests in accordance to 49CFR 173 Subpart B, Appendix C and 49 CFR 178. **NOTE:** If only one configuration sample is tested, test duration shall be 3 hours.

F. Fiberboard Water Resistance (Cobb) Test. One test per fiberboard specimen, total of six.

Strong, solid or double faced corrugated fiberboard (single or multi-walled) must be used, appropriate for the capacity and the intended use of the box. The water resistant outer surface must not increase in mass greater than **155 grams per meter² (0.0316 pounds per foot²)** after 30 minutes in accordance with International Standards Organization (ISO) 535 or Technical Association of the Pulp and Paper Industry (TAPPI) T441 or ASTM D 3285. Three individual fiberboard specimens shall be exposed on the wire side and another three on the felt side.

Part 5. Criteria for Passing Tests.

A. Leakproofness Test. There must be no leakage of air from the packaging. **Not applicable.**

B. Hydrostatic Pressure Test. Any leakage is cause for rejection.

C. Stacking Test.

No test sample shall leak. Composite and combination containers shall not exhibit leakage of the filling substance from the inner receptacle or container. No test sample shall show deterioration which adversely affects transportation safety or show any distortion liable to reduce its strength, cause stacking instability, or cause damage to internal container components likely to reduce transportation safety.

D. Drop Test.

Each packaging containing liquids shall be leakproof when internal and external pressures are equalized. Composite and combination containers shall not exhibit damage to the outer packaging likely to adversely affect transportation. In addition, the inner packaging shall not leak into the filling substance or lading.

E. Vibration Test.

No rupture or leakage from any of the packages. No test specimen shall show any deterioration which could adversely affect transportation safety, result in possible discharge of contents or reduce packaging strength.

F. Fiberboard Water Resistance Test.

The calculated water absorption of all samples shall be less than **155 g/m²**.

Part 6. Discussion and Test results.

Narrative description of test results, including any rationale for variations. For each packaging to pass, all applicable tests must be performed and pass criteria listed herein.

A. Leakproofness Test. Not applicable.

B. Hydrostatic Pressure Test. Manufacturer test results acceptable for Hazmatpac Locking Ring.

C. Drop Test. Pass

Tested at standard conditions: 23°C, 50% RH. Each packaging was dropped 1.8 meters onto the required four flat sides and a top corner. There was no damage after any one drop, to any of the outer packagings, that would be likely to cause leakage from, or weakening of, the package during transportation. The sides of the cans packaged in all 3 absorbents were dented, and the bottom edges dented and crimped which, in turn, caused bulging of the lids. In the packagings using GP and A900 this damage was severe enough to result in leakage of both sand and water from the bottom edge and lid of the cans. **Therefore, only the packaging using vermiculite as the absorbent cushioning passed this test.** See Figures 5 and 8 - 10.

D. Stacking Test. Pass

Duration: 72 hours at standard conditions: 23°C, 50% RH. One empty closed outer container was stacked with 700 lb for 72 hours. There was no damage to the box which could result in damage to the inner item, no crushing, nor stack instability. No other adverse results were noted. See Figure 6.

E. Vibration Test. Pass

Duration: 3 hours at ambient. The same packagings used in the drop tests were also used for the vibration test. Each packaging was tested on an electro-hydraulic vibration table which was set at 1-inch vertical double amplitude (peak-to-peak) displacement, at a frequency such that the packaging was raised from the platform. The distance was measured using a 1/16-inch feeler gage. At approximately 4.0 Hz the feeler gage could be passed between the bottom of the package and the table surface. There was no additional damage to the outer container caused by the vibration and no leakage from the inner containers. This test procedure duration of 3 hours with one container exceeds the 49 CFR requirements. See Figure 7.

F. Water Resistance (Cobb) Test. Pass

Test at standard conditions: 23°C, 50% RH.

As required by 49 CFR part 178.516, ASTM D 3285 Water Absorptiveness of Nonbibulous Paper and Paperboard (Cobb Test) was performed on specimens cut from the lot of boxes used in the drop stack and vibration tests. The test period (exposure of the samples to water) was 30 minutes.

5 Specimens were tested on the exterior side. Average **114.0 g/m²**.

5 Specimens were tested on the interior side. Average **118.0 g/m²**.

0 Specimens exceeded the 155 grams per square meter maximum limit.

Part 7. Performance Marking on Container:

The container specified herein passes the DoT and international regulatory requirements to the extent tested. Equivalent DoD built or grandfathered containers MAY also qualify for the following marking as directed by DoD policy documents.



NOTE: Ensure air eligibility marking is added as required by ICAO/IATA, 49 CFR, and AFMAN 24-204(I), A14.3.6.

Part 8. References

- A. 49CFR 170-180
- B. DLAD 4145.41/AR 700-143/AFJI 24-210/NAVSUPINST 4030.55A/MCO 4030.40A - Packaging of Hazardous Materials
- C. ISO 535/TAPPI T 441/ASTM 3285 - Determination of Water Absorption of Paper and Board (Cobb Method)
- D. ISO 3574 - Cold-reduced carbon steel sheet of commercial and drawing quantities.
- E. ASTM D999 - Methods for Vibration Testing of Shipping Containers.

Part 9. Distribution List

Commander
Defense Logistics Agency
DDC-J-3/J-4-0
ATTN: POP Team
2001 Mission Drive
New Cumberland PA 17070

AFMC LSO/LOP
Project Folder

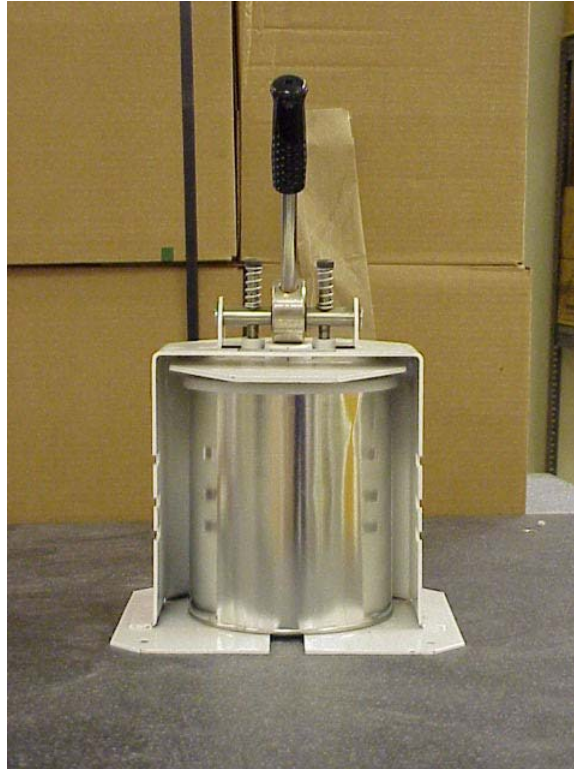


Figure 1. Closed and sealed metal can in applicator tool.



Figure 2. Metal cans in box..



Figure 3. Closure of inner liner enclosing cushioning absorbent.



Figure 4. Closure of outer containers (top, bottom and side).

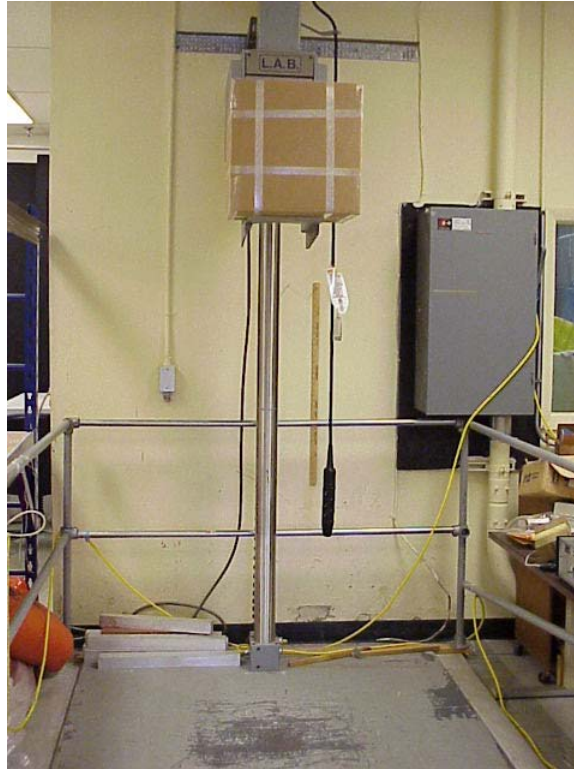


Figure 5. Drop test.

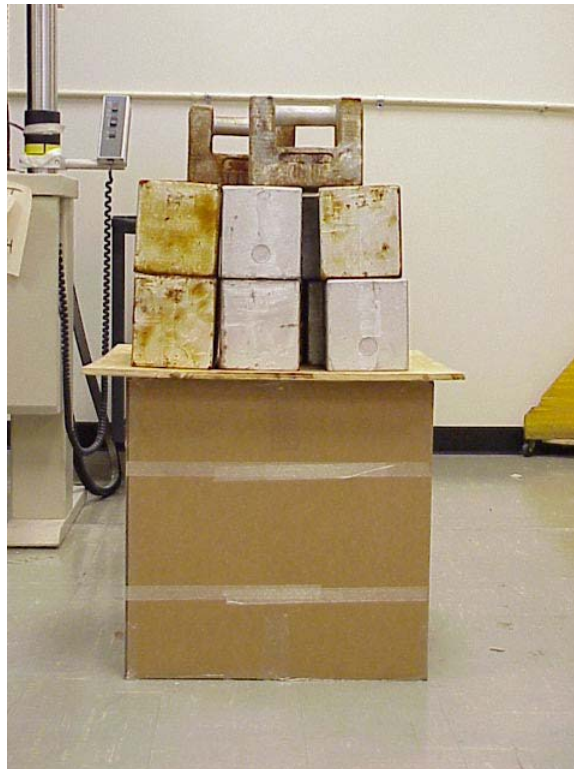


Figure 6. Stack test performed on empty outer container.



Figure 7. Vibration test.



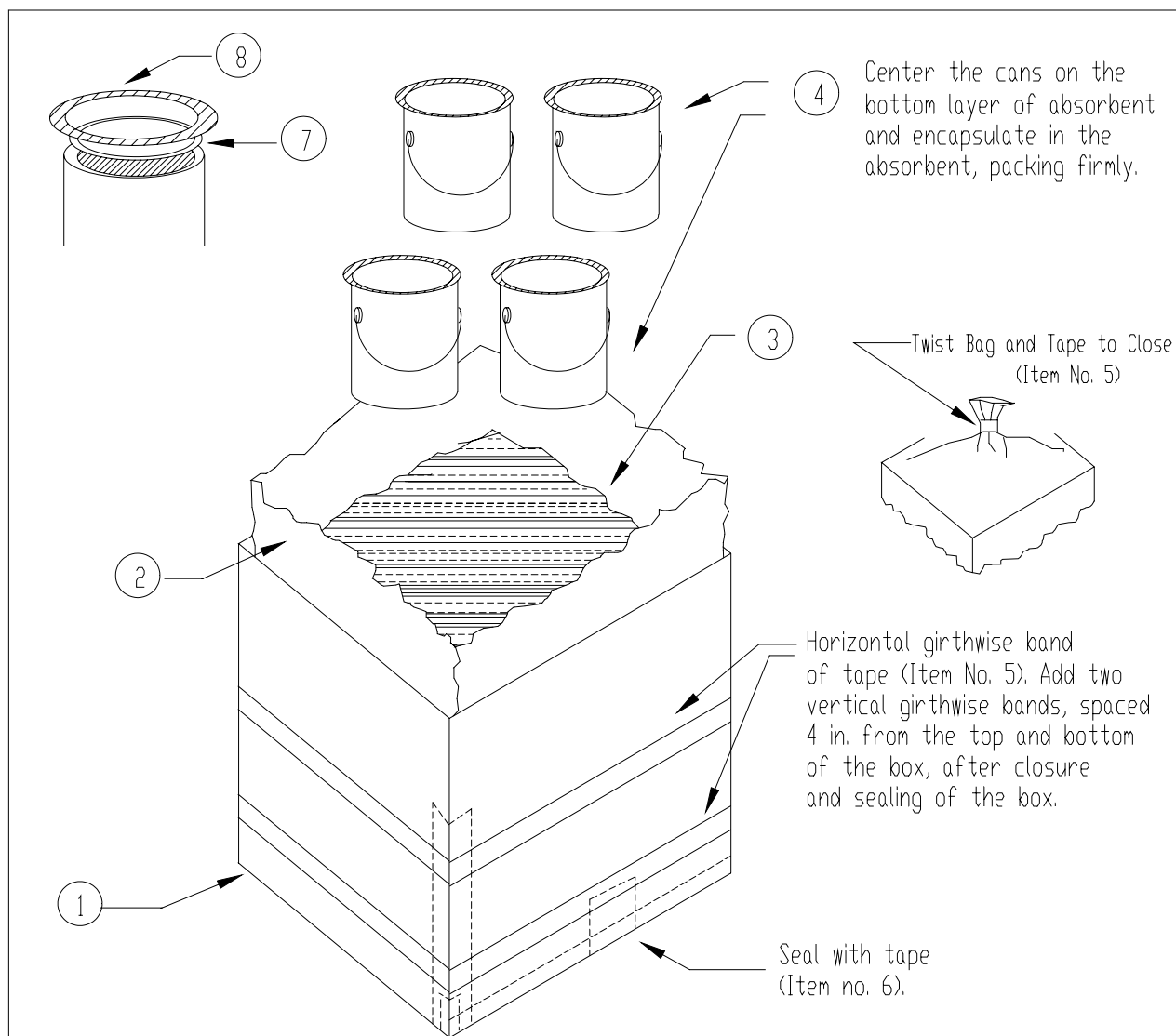
Figure 8. Damage to cans packaged in vermiculite.



Figure 9. Damage to cans packaged in A900.



Figure 10. Damage to cans packaged in GP



8	A/R	Ring Lock	Hazmatpac Stock No. C-700
7	A/R	Can Lid	
6	A/R	Sealing Tape	NSN 7510-00-266-6715
5	A/R	Fiber Reinforced Tape	NSN 7510-00-582-4772
4	4	Metal Paint Can	Freund Stock No. 1837
3	A/R	Absorbent Fill	Vermiculite only
2	1	4-mil LDPE Bag	Min. Dim. 22 in. x 22 in. x 47 in.
1	1	Single Wall Corrugated Fiberboard Box	NSN 8115-00-190-5002, 16 in. x 16 in. x 16 in.
Item	Qty	Description	Notes
		AFPTEF Air Force Packaging Technology and Engineering Facility	Note: Follow All Instructions in TR
File: DLAF058-04.DWG			Dimensions in Inches
Dwg No: DLAF05804			Scale: NONE
Engineer: SJ Evans		DATE: 30 April 04	PAGE 1 OF 1